Chapter 13

Spider Science

Description

This lesson explores the secret lives of spiders, focusing on how they spin silk, build webs, and capture their prey. By undertaking a design challenge, students discover that spiderwebs are carefully engineered, intricate structures that spiders know how to build without ever being taught. Students also learn how genetic information is passed from parent to offspring, how inherited and acquired traits differ, and how scientists design experiments to study animal behavior in space.

Suggested Grade Levels: 3–5

LESSON OBJECTIVES Connecting to the *Framework*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concept**
Constructing Explanations and Designing Solutions	**LS3.A:** Inheritance of Traits **LS3.B:** Variation of Traits **ETS2.A:** Interdependence of Science, Engineering, and Technology	Cause and Effect

Featured Picture Books

TITLE: ***Next Time You See a Spiderweb***
AUTHOR: **Emily Morgan**
PUBLISHER: **NSTA Press**
YEAR: **2015**
GENRE: **Non-Narrative Information**
SUMMARY: *Stunning, up-close photography and clear text reveal the surprising secrets of spiders and their webs.*

TITLE: ***Nefertiti, the Spidernaut: The Jumping Spider Who Learned to Hunt in Space***
AUTHOR: **Darcy Pattinson**
ILLUSTRATOR: **Valeria Tisnés**
PUBLISHER: **Mims House**
YEAR: **2016**
GENRE: **Narrative Information**
SUMMARY: *The extraordinary story of a tiny jumping spider that spent 100 days on the International Space Station learning how to hunt in microgravity.*

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Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with *Next Time You See a Spiderweb* Read-Aloud, Part 1, and **Explore** with Spiderweb Design Challenge

Day 2: **Explain** with Spiderweb Videos and *Next Time You See a Spiderweb* Read-Aloud, Part 2

Day 3: **Explore** with Inherited Versus Acquired Traits Card Sort and **Explain** with Inherited Versus Acquired Traits Discussion

Day 4: **Elaborate** with *Nefertiti, the Spidernaut* Read-Aloud and Videos

Day 5: **Evaluate** with Animals in Space Research Proposal and Animals in Space Research Proposal Presentations

Materials

For Next Time You See a Spiderweb *Read-Aloud*

- Spiderweb Cards (1 precut set per group of 4 students)

For Spiderweb Design Challenge

- White acrylic yarn (approximately 10 yards per student, approximately 1 skein per class)
- Scissors
- Tape
- Plastic spider (*Note*: 1 ½ in. plastic spiders [72-pack] are available at Amazon.com for about $10.00.)
- Paper plates (black or other dark color)
- Disposable cups
- Straws
- Cotton balls

SAFETY

Use caution when working with scissors. They are sharp and can puncture the skin or eyes.

Student Pages

- Spiderweb Design Challenge
- Inherited Versus Acquired Traits Sorting Cards
- Animals in Space Research Proposal Rubric
- Animals in Space Research Proposal
- STEM at Home

Background for Teachers

The characteristics that an organism inherits from its parents are called *traits*. In humans, traits include such things as hair color, eye color, skin color, blood type, and even the shape of the earlobes. These traits are determined by the information passed from parents to their children by *genes*, which are the fundamental units of inheritance in living organisms. Genes are regions of *DNA*, long double-helix structures

that form a cell's chromosomes. Genes control how an organism looks, behaves, and reproduces. It is currently estimated that humans have around 19,000 different genes (Ezkurdia et al. 2014). The branch of science that studies how traits are passed from one generation to the next is called *genetics*. Genetics affects all living things, from miniscule bacteria to massive blue whales.

Inheritance is the reason that offspring resemble their parents—kittens look like cats, puppies look like dogs, snakelets look like snakes, and spiderlings look like spiders. Baby animals such as tadpoles and caterpillars don't look exactly like their parents at first; they must go through a metamorphosis. But once they grow into adults, such organisms do look like their parents. Because each parent (in most multicellular organisms) contributes only half of the genetic information that makes up its offspring, offspring are not exact replicas of their parents.

Inheritance isn't the whole story, however. Genes may determine the *inherited traits* that are passed from parent to offspring, but the environment can also shape the development, appearance, behavior, and survival of an individual organism. The chemicals they are exposed to, the foods they eat, and the experiences they have all help shape organisms' *acquired traits*. For example, a normally tall sunflower plant can be stunted by lack of sunlight. A tomato plant can bear more fruit if given the right fertilizer. A dog can become obese by eating too many dog treats. A dolphin that lost part of its tail can learn to swim again by moving in a different way. A garden spider exposed to caffeine spins irregular webs. A jumping spider can learn to hunt in a microgravity environment.

Not all of the traits that organisms inherit can be modified by environmental influences. In humans, for example, blood type is an inherited trait that will not change, whereas the tendency to be tall or short can be modified by how fast you grow, what you eat, childhood illnesses, and other factors.

Upper-elementary students should understand that many characteristics of organisms are inherited from their parents, other characteristics result from individuals' interactions with the environment, and some characteristics involve both inheritance and the environment. To engage students in these core ideas, this lesson begins with a read-aloud of a book about spiders and their webs. Students learn through a fun design challenge that spiderwebs are elaborate and difficult to build. Through reading, they learn that spiders can build these carefully engineered structures without having a single lesson. This skill is called an *inherited trait* (also known as an *instinctive behavior*). Each kind of spider builds the same type of web that its parents build. Other traits that spiders inherit from their parents are the physical characteristics that they are born with: eight legs, fangs, spinnerets, body shape and coloring, and so on. As opposed to inherited traits, *acquired traits* are shaped by an individual organism's environment. Students are introduced to acquired traits in animals through the true story of a jumping spider named Nefertiti. NASA sent her to the International Space Station (ISS) as part of a research project proposed by an 18-year-old science whiz kid named Amr Mohammed. Amr's hypothesis was that the spider would not be able to hunt in the microgravity environment of the ISS. Astonishingly, after many failed attempts, she developed a hunting behavior that allowed her to catch fruit flies in space! Nefertiti not only learned to hunt in a new way but also learned to re-adapt to her inherited, or instinctive, method of hunting once she returned to Earth.

The crosscutting concept of cause and effect is developed in this lesson as students learn that some traits in organisms are caused by their genetics (inherited traits) and others are caused by factors in an organism's environment (acquired traits). They also explore an unusual cause of acquiring new behaviors—being sent into orbit and living in microgravity! Students are engaged in the science and engineering practice of constructing explanations and designing solutions throughout this lesson. First, they are challenged to design and build a model of a spiderweb. Then, they learn how scientists designed a

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habitat that could support the basic needs of a spider at the ISS and how an experiment was set up to test Amr's hypothesis. Through this example, students learn how science and technology support each other. Finally, they submit an Animals in Space Research Proposal in which they design an experiment to study learned behaviors of animals in microgravity.

engage

Next Time You See a Spiderweb Read-Aloud, Part 1

Connecting to the Common Core
Reading: Informational Text
Craft and Structure: 3.6

Show students the cover of *Next Time You See a Spiderweb* and introduce the author, Emily Morgan. Tell students that, although many people are afraid of spiders, she is not! The author wanted to write a book about spiders and their webs so more people would realize that spiders are fascinating and beneficial animals with some cool adaptations. In other words, she wants people to say "Ooh!" when they spot a spider instead of "Ick!" She also wants her books to inspire adults and children to spend time together outdoors, experiencing the joy, excitement, and mystery of the natural world together.

Making Connections: Text to Self

Before reading, ask students to turn to a neighbor and discuss the following questions:

- ? Do you like to spend time outside observing nature?
- ? What kinds of spiders have you observed (either inside or outside)?
- ? What kinds of spiderwebs have you seen?
- ? How do *you* feel about spiders?

Then, pass out a set of Spiderweb Cards to each group of four students. (*Note:* Cut them out for each group beforehand.) Have students discuss the similarities and differences they notice about the webs. Tell students that you would like them to signal when they hear about each kind of web by holding up the picture of the web as you read.

Next, read pages 4–21 of *Next Time You See a Spiderweb*, pausing to discuss the characteristics of each type of web as you read about it. Stop after reading, "It is astonishing that these small creatures are able to make such elaborate and efficient traps without a single lesson! Spiders are born knowing how to build webs—they don't need anyone to teach them." *Ask*

- ? How do spiders know how to spin webs?
- ? Do you think it is easy or difficult for a spider to build a web?
- ? Do *you* think you could build a spiderweb?

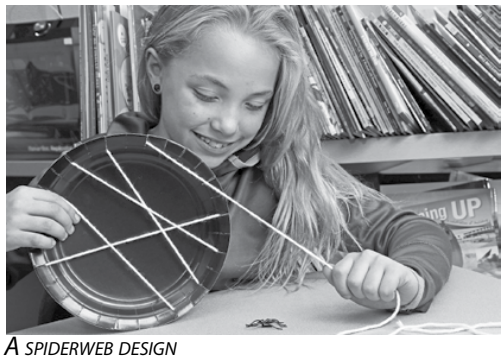
explore

Spiderweb Design Challenge

Tell students that you have a challenge for them! Their challenge is to design and build a model of a spiderweb, using no more than 10 yards of yarn and some tape. They may also use paper plates, cups, straws, and cotton balls if desired. They may choose to build any of the webs from the Spiderweb Cards: orb web, funnel web, sheet web, or cobweb. Remind students that, for any engineering challenge, they should first brainstorm possible solutions and then design a solution by sketching it out on paper before building it. Pass out the Spiderweb Design Challenge student page. Tell students that after they design their web, they must get approval from you at the Teacher Checkpoint before building.

As students brainstorm and make sketches, give suggestions and feedback. One hint is to cut small slits around the edges of the paper plate to serve as places to hold the yarn as they loop it around. If they are attempting an orb web, they should form the "radial lines" first and secure them to

the paper plate with tape. Once they do that, they can loop segments of yarn around the radial lines to make the spiraling "orb lines" that go around and around the web. To make a cob web, students can crisscross the yarn around the plate in a more random, disorganized way. To make a funnel web, students can try cutting out the center of the paper plate to create a circular frame at the opening of the funnel and then wrap a cup in yarn to create the bottom of the funnel. To make a sheet web, students can crisscross lines of yarn above the plate using straws to support it and then pull apart cotton balls to create a sheet on another plate below. As you approve each design, allow students to begin building their models. You may want to set a time limit for building.



A SPIDERWEB DESIGN

After students have completed their spiderweb models and secured the plastic spiders to them, have each student make a label with his or her name and the type of web built and attach it to the model. You may want to display the finished models on a bulletin board, hang them from the ceiling, or display them in the hallway. Halloween is a great time of year to do this activity!

explain

Spiderweb Videos

Ask

? How easy or difficult was it to build your spiderweb model?

? Did you try any designs that didn't work?

? What would you do differently?

? Do you think building webs is difficult for spiders?

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: 3.1, 4.1, 5.1

Orb Web Video

Have students watch the 1 min. time lapse video of a garden spider spinning an orb web (see "Websites" section). After watching, *ask*

? What did you notice about the spider's web-building technique?

? How did it compare with your technique?

Remind students that the book said, "Spiders are born knowing how to build webs—they don't need anyone to teach them." Explain that most animals are born "knowing" how to do many things. These instincts are known as *inherited traits*. Offspring *inherit*, or get, these behaviors from their parents. The information is passed from parent to offspring through tiny structures in cells called *genes*. Baby spiders, or spiderlings, have the instinct to build webs "pre-programmed" into their genes. Their parents don't have to teach them!

Spiderlings Video

Show the 2 min. video called "Young Garden Spiders Emerging and Spinning Webs" (see "Websites" Section), and have students watch as dozens of garden spiderlings emerge from their eggs and begin spinning webs without a single lesson from their parents. After watching, *ask*

? Did you observe any adult spiders teaching the spiderlings how to spin webs? (no)

? What do you call animal behaviors that are instinctive (do not have to be learned)? (inherited traits)

? What physical characteristics of the baby spiders did you notice as you watched? (The

spiderlings had eight legs, spinnerets, a yellowish color, round abdomens with a dark spot, etc.)

Show the picture of an adult garden spider on page 11 of *Next Time You See a Spiderweb*. Explain that baby garden spiders look pretty much like their parents (except they are smaller and their color and markings are a little different). Their physical characteristics, such as their body shape and having eight legs, fangs, spinnerets for making silk, and so on are inherited from their parents through genes. Because of genetic inheritance, all living things look a lot like their parents. Genes are passed from generation to generation. So garden spider spiderlings grow into adult garden spiders. Jumping spider spiderlings grow into adult jumping spiders. Trapdoor spider spiderlings grow into adult trapdoor spiders. (It is important to note that some baby animals such as tadpoles and caterpillars don't look exactly like their parents at first; they must go through a metamorphosis. But once they grow into adults, they do look like their parents.)

Explain that inherited traits are only one piece of the puzzle, however. It is true that many characteristics of organisms are inherited from their parents. For example, tiger cubs are born with stripes. Baby sea turtles are born with the instinct to scurry to the ocean after hatching. Sunflowers tend to grow tall. But other characteristics can result from an organism's interactions with its environment. These characteristics are known as *acquired traits*. The following are examples of acquired traits:

- A spider exposed to caffeine spins irregular webs.
- A tomato plant can bear more fruit if given the right fertilizer.
- A cat can become obese by eating too many cat treats.
- A sea turtle can lose a flipper in a collision with a boat.
- A normally tall sunflower plant can be stunted by being grown in the dark.
- A tiger cub learns to hunt prey by watching its parents.
- A chimpanzee can learn sign language.
- A dolphin that loses part of its tail can learn to swim again by moving in a different way.

The organisms in those examples of acquired traits did not inherit the traits from their parents. The traits were not passed through genes. Instead, they resulted from learning or from the individual organism's interactions with its environment. All of these things can help shape an organism's acquired traits: the chemicals they are exposed to (the spider exposed to caffeine, the tomato plant given fertilizer), the foods they eat (the cat eating too many cat treats), the things that happen to them (the dolphin losing part of its tail, the sea turtle losing a flipper, the sunflower being put in the dark), and the behaviors they learn (the tiger cub learning to hunt, the chimpanzee learning sign language, the dolphin learning to swim a different way). Acquired traits *cannot* be passed on through genes. For example, a sea turtle that loses a flipper in an accident does not have three-flippered babies. A chimpanzee that learns sign language does not give birth to a baby chimpanzee that knows sign language.

Some characteristics of organisms involve *both* genetic inheritance and environment. For example, a fair-skinned boy inherits his skin color from a combination of his parents' genes for skin color. If this child spends too much time in the sun, he can get a bad sunburn. The reddened skin that results is a combination of an inherited trait (being born with fair skin) and a trait acquired from his environment (a sunburn from spending too much time in the sun).

Next Time You See a Spiderweb Read-Aloud, Part 2

Questioning

Next, tell students you are going to read the rest of the book *Next Time You See a Spiderweb,* and have them watch for examples of inherited traits. Before reading, *ask*

? Do all spiders inherit the ability to make webs?

? Do all spiders inherit the trait of producing silk?

? How strong is spider silk?

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: 3.1, 4.1, 5.1

Then, read the rest of the book aloud (pages 22 to end.) After reading, *ask*

? Do all spiders inherit the ability to make webs? (no)

? What kinds of spiders do *not* spin webs? (jumping spiders, fishing spiders, trapdoor spiders—about half of spider species have other clever ways to catch food)

? How do jumping spiders catch food? (They use their excellent vision to detect prey, and then they pounce on it.)

? Do you think a jumping spider's way of catching food is inherited or learned? (inherited)

? Do all spiders inherit the trait of producing silk? (yes)

? How strong is spider silk? (Some spider silk is stronger than a thread of steel, and some can stretch up to three times its length without breaking.)

? Why do scientists and engineers study spider silk? (Scientists are trying to mimic spider silk to create ultra-strong materials; engineers are studying it to design structures that can withstand disasters such as earthquakes.)

Synthesizing

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: 3.2, 4.2, 5.2

Next, *ask*

? What is the main idea of *Next Time You See a Spiderweb*? (A spiderweb is a trap.)

? How is the main idea supported by details? (The book has many photographs of spiderwebs, describes different ways that spiders use webs to trap food, and explains the strength of spider silk.)

explore

Inherited Versus Acquired Traits Card Sort

The following activity will help students explore and understand the difference between inherited traits and acquired traits. Give each pair of students a sheet of Inherited Versus Acquired Traits Sorting Cards, and have students cut them out. Students should work with their partners to sort the cards into two groups: inherited traits and acquired traits. Remind students that inherited traits are those genetic characteristics an organism gets from its parents; acquired traits are those characteristics that an organism learns receives from its environment.

Sorting the cards

explain

Inherited Versus Acquired Traits Discussion

Visit each pair as they work, and have students explain their answers to the following questions:

? Why did you place that card where you did?

Table 13.1. Inherited Traits Versus Acquired Traits: Card Sort Answers

Inherited Traits	Acquired Traits
A trout swimming in a stream	A wolf cub learning to hunt in a pack with other wolves
A dalmatian puppy being born with spots	A parrot saying "Hello!"
A sunflower plant in a window growing toward the sunlight	A girl speaking English and Spanish
A garden spider hatching from an egg and spinning a web	A beagle eating so many dog treats that it gets obese
A robin laying an egg in a nest	A bean plant in a dark closet turning yellow
A tiger cub being born with stripes	A jumping spider losing a leg to a centipede
A boy having brown eyes	A goldfish swimming to the top of a bowl when it sees your hand holding food

- ? Did you get stuck on any of the examples? Why?
- ? Can you think of other examples of inherited traits?
- ? Can you think of other examples of acquired traits?
- ? What are you wondering about inherited traits and acquired traits?

Answers to the card sort are shown in Table 13.1.

Next, have students think about their own traits. *Ask*

- ? What inherited traits do you have? (hair color, eye color, and so on)
- ? What acquired traits do you have? (language, learned skills, and so on)

You may want to have students make a chart of their own called Inherited Traits Versus Acquired Traits.

elaborate

Nefertiti, The Spidernaut Read-Aloud and Videos

Connecting to the Common Core
Reading: Informational Text
Craft and Structure: 3.6

Show students the cover of *Nefertiti, the Spidernaut: The Jumping Spider Who Learned to Hunt in Space* by Darcy Pattison (illustrated by Valeria Tisnés). Explain that this book is a true story about a jumping spider that was sent to the International Space Station (ISS) as part of a research project. The idea for the experiment was proposed by an 18-year-old Egyptian student named Amr Mohammed through a YouTube Space Lab global competition. Amr's hypothesis was that a jumping spider would not be able to catch its prey in the microgravity environment of the ISS. Explain that *microgravity* is the condition in which people or objects appear to be weightless, as is the case on the ISS orbiting 200–250 miles above Earth. Show the 2:18 min. video

called "Meet Amr From Egypt," which is about Amr and his proposal (see "Websites" section).

Next, read the following quote from the author of *Nefertiti*:

> *When I interviewed Sunita Williams, the astronaut who cared for Nefertiti, she called the spider her 'scary friend.' I know that spiders are often scary to kids, but here's an interesting fact. Worldwide, there are around 50,000 spider species and only about a dozen are dangerous. In the U.S., only the black widow and brown recluse can be deadly to humans. The chances of your meeting a spider that is dangerous is unlikely. I love the book's cover, a close-up of the Johnson jumping spider. She's beautiful. Sometimes spiders are scary; but they can also be a friend. For Sunita, it was comforting to have another living creature with her on the space station, especially when the spider stopped and watched her moving around. (personal correspondence)*

Then, *ask*

- ? How do you think the author, Darcy Pattison, feels about spiders? (Answers will vary, but students will likely say that the author likes spiders.)
- ? How do you think Emily Morgan, the author of *Next Time You See a Spiderweb*, feels about spiders? (Answers will vary, but students will likely say that the author thinks spiders are fascinating.)
- ? What do their feelings tell you about how authors of nonfiction books might choose their topics? (They are probably very interested in, curious about, or even fond of the subjects of their books.)

Tell students that it would be hard to write a book about something you didn't really care about!

Inferring

Before reading *Nefertiti*, *ask*

- ? What did you learn about how jumping spiders catch their prey from the book *Next Time You See a Spiderweb*? (They use their excellent vision to detect prey, and then they pounce on it.)
- ? Is this behavior inherited or acquired? (inherited)
- ? In microgravity, objects are almost weightless, but not quite. How do you think microgravity would affect a jumping spider's ability to hunt and catch prey? (Answers will vary.)

Then, read the book aloud. After reading, you may want to show the 57 sec. video called "Jumping Spider, Nefertiti, Onboard the International Space Station" so that students can observe for themselves the spider's attempts at hunting in microgravity and her re-adaptation to Earth's gravity (see "Websites" section).

Next, read the following excerpt from Amr's SpaceLab experiment description.

> *Jumping spiders have very good vision that they use to track and stalk prey. Unlike orb weavers, the jumping spider does not spin a web to capture food. Jumping spiders are hunters. They move around during the day seeking prey. Once it visually identifies prey, [the jumping spider] may stalk it for some distance prior to catching it. Once the jumping spider is within close proximity of its prey, it will secure a drag line using its silk and then jump with great speed onto the prey securing it with a lethal bite. The drag line acts as a safety harness in case the spider should miss its target and fall. This experiment seeks to determine if the jumping spider alters its predation technique in a microgravity environment. (YouTube Space Lab 2016)*

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Questioning

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: 3.1, 4.1, 5.1

Scientists usually present a problem statement, or something they want to investigate, when they write a research proposal. In this proposal, scientists wanted to find out if a jumping spider could hunt in microgravity.

Next, have students think back to the book *Nefertiti*. *Ask*

- ? What did Amr think would happen if a jumping spider was sent to space? (He predicted it would not be able to hunt in microgravity.)
- ? How did scientists investigate this? What were their methods? (They chose a spider to use in the experiment. They designed a special habitat for her. They tested to see if she could survive in the habitat on Earth. Then, they sent her to space on an unmanned cargo carrier. After she arrived on the ISS, they videotaped her attempts to hunt.)
- ? What new technology had to be invented to do this investigation? (A special habitat had to be designed for the spider to live in.)
- ? What did scientists discover? (A jumping spider could adapt to microgravity and learn to hunt in a new way.)
- ? Do you think this new way of hunting would be considered an inherited trait or an acquired trait? (acquired trait)
- ? What surprised the scientists when she returned to Earth? (She re-learned how to hunt on Earth.)
- ? How do you think Amr felt about the results of the experiment? (Answers will vary.)

evaluate

Animals in Space Research Proposal

Connecting to the Common Core
Writing
Text Types and Purposes: 3.2, 4.2, 5.2

Writing

Ask students to think about Amr's ingenious idea for an experiment and what scientists learned from it. Tell them that they are going to have an opportunity to propose their own experiment to test animal behavior in space! They will first write their proposal and then record a video (2 min. or less) for others to see. Their proposal won't actually be part of a global competition, but it will be used to evaluate what they have learned about organisms' inherited versus acquired traits. (For fun, you could ask other teachers to watch their proposal videos and give feedback.) Tell students that a good research proposal is like a good sales pitch! It should be clear, concise, and compelling. In other words, their research proposal should be easy to understand, informative, and contain many supporting details. It should not be too long, and it should be original and interesting.

Recording a research proposal

Pass out the Animals in Space Research Proposal and the Animals in Space Research Rubric. Review the requirements for each component. You may want to re-read the SpaceLab experiment description on jumping spider predation as an example of a strong start to a proposal. Have students brainstorm different animals, choose appropriate subjects for experiments in space, research their subject animals and then complete their proposals using the rubric as a guideline.

Animals in Space Research Proposal Presentations

Connecting to the Common Core
Speaking and Listening
Presentation of Knowledge and Ideas: 3.4, 4.4, 5.4

Have students share their completed videos with the class, or invite other classes to attend. Use the rubric to evaluate their video presentations.

STEM at Home

Have students complete the "I learned that …" and "My favorite part of the lesson was …" portions of the STEM at Home student page as a reflection on their learning. They may choose to do the following at-home activity with an adult helper and share their results with the class. If students do not have access to the internet or these materials at home, you may choose to have them complete this activity at school.

"At home, we can watch a video from Wild Kratts called 'Make a Web,' which shows how some spiders make orb webs and how spiders use different kinds of silk for different jobs."

Search for "Wild Kratts Make a Web" on www.pbslearningmedia.org *to find the video at* www.pbslearningmedia.org/resource/371aa09e-46d0-4665-8a80-5ca94f6cf423/make-a-web-wild-kratts.

"After we watch the video, we can write the steps a spider takes to build an orb web [answers shown in parentheses]:

1. First, (the spider makes a frame).
2. Then, (the spider drops a silk line down the center).
3. Next, (the spider puts in the spokes).
4. Finally, (the spider adds the spiral)."

For Further Exploration

This section is provided to help you encourage your students to use the science and engineering practices in a more student-directed format. This box lists questions and challenges related to the lesson that students may select to research, investigate, or innovate. Students may also use the questions as examples to help them generate their own questions. After selecting one of the questions in the box or formulating their own questions, students can individually or collaboratively make predictions, design investigations or surveys to test their predictions, collect evidence, devise explanations, design solutions, or examine related resources. They can communicate their findings through a science notebook, at a poster session or gallery walk, or by producing a media project.

Research

Have students brainstorm researchable questions:

? What is spider silk made of, and how strong is it? Which spiders make the strongest silk?

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- What kinds of animal research projects have been done in space?
- How do chimpanzees learn sign language?

Investigate

Have students brainstorm testable questions to be solved through science or math:

- Survey your friends and family: Do you think spiders are "Ooh!" or "Ick!"? Graph the results, then analyze your graph. What can you conclude?
- Survey your family and friends: What inherited traits do they have? (widow's peak or straight hairline, attached earlobes or detached earlobes, can roll tongue or can't roll tongue, left handed or right handed) Graph the results, then analyze your graph. What can you conclude?
- Can you find the ISS in the night sky? (go to *spotthestation.nasa.gov* and enter your location)

Innovate

Have students brainstorm problems to be solved through engineering:

- If scientists could make artificial spider silk, what would be some potential uses for it?
- Can you design a habitat for a tarantula in space?
- Can you design a habitat for a pet to keep astronauts on the ISS company?

Reference

Ezkurdia, I., D. Juan, J. M. Rodriguez, A. Frankish, M. Diekhans, J. Harrow, J. Vazquez, A. Valencia, and M. L. Tress. 2014. Multiple evidence strands suggest that there may be as few as 19,000 human protein-coding genes. *Human Molecular Genetics* 23 (22): 5866–5878.

YouTube Space Lab. 2016. ISS science for everyone. NASA. *www.nasa.gov/mission_pages/station/research/experiments/208.html.*

Websites

"Jumping Spider, Nefertiti, Onboard the International Space Station" (video)
www.youtube.com/watch?v=EPPGQeZ4aw4

"Meet Amr From Egypt" (video)
www.youtube.com/watch?v=2YV1WHjNs4E

Orb Web Time Lapse: "Why Do Spiders Spin Webs?" (video)
http://wonderopolis.org/wonder/why-do-spiders-spin-webs

Spiderlings: "Young Garden Spiders Emerging and Spinning Webs" (video)
www.arkive.org/garden-spider/araneus-diadematus/video-09c.html

More Books to Read

Bardoe, C. 2015. *Gregor Mendel: The friar who grew peas.* New York: Abrams.
Summary: Watercolor illustrations and clear text explain the theory of heredity in simple-to-understand language and examples. Regarded as the world's first geneticist, Gregor Mendel discovered one of the fundamental aspects of genetic science: Animals, plants, and people all inherit and pass down traits through the same process.

Berger, M. 2003. *Spinning spiders*. New York: HarperCollins.
Summary: From the *Let's-Read-and-Find-Out Science* series, this book featuring remarkably realistic artwork by S. D. Schindler, teaches about the silk spiders produce, the webs they spin, and the prey they capture.

Bishop, N. 2007. *Spiders*. New York: Scholastic.
Summary: Nic Bishop's signature up-close, stop-action photographs show spiders larger than life. Amazing images show the beauty and otherworldliness of spiders. Simple, engaging text conveys basic information about spiders as well as cool and quirky facts.

Boothroyd, J. and B. Silverman. 2011. *What traits are in your genes? Lightning Bolt Books* series featuring volumes on body parts, eye color, facial features, hair traits, unusual traits, and vison. Minneapolis, MN: Lerner.
Summary: Simple text, vivid photographs, and a colorful design illustrate how we inherit genetic traits, while familiar examples make abstract concepts easy to grasp. Back-matter special features, including glossaries and further reading pages, bolster these informative texts.

Green, J. 2014. *Inheritance of traits: Show me science: Why is my dog bigger than your dog?* North Mankato, MN: Raintree.
Summary: This book teaches children about genes and the inheritance of traits through the engaging topic of dogs.

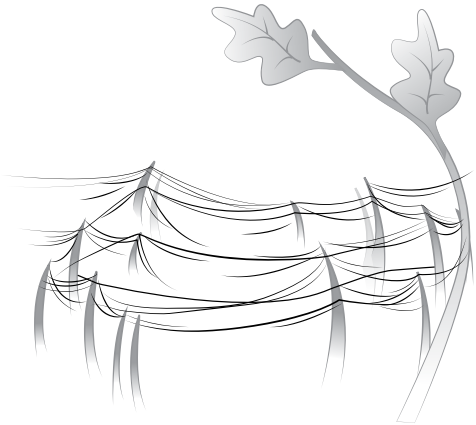
Heos, B. 2013. *Stronger than steel: Spider silk DNA and the quest for better bulletproof vests, sutures, and parachute rope.* Boston: HMH Books for Young Readers.
Summary: From the *Scientists in the Field* series, this book takes older readers into the lab of Dr. Randy Lewis, where goat embryos are injected with genes from golden orb weaver spiders. When the goats mature, some of the females will produce spider silk proteins in their milk. This project aims to produce threads of varying degrees of strength and flexibility typical of spider silk.

Simon, S. 2007. *Spiders: All about their web-building skills, bodies, diets, and more!* New York: Harper Collins.
Summary: Stunning full-color, up-close photographs and interesting text introduce the physical characteristics, behaviors, and life cycles of different kinds of spiders.

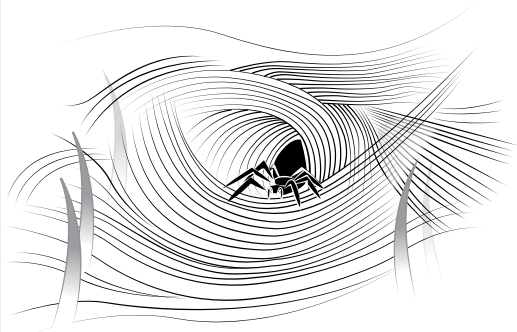
Name : _____

Spiderweb Cards

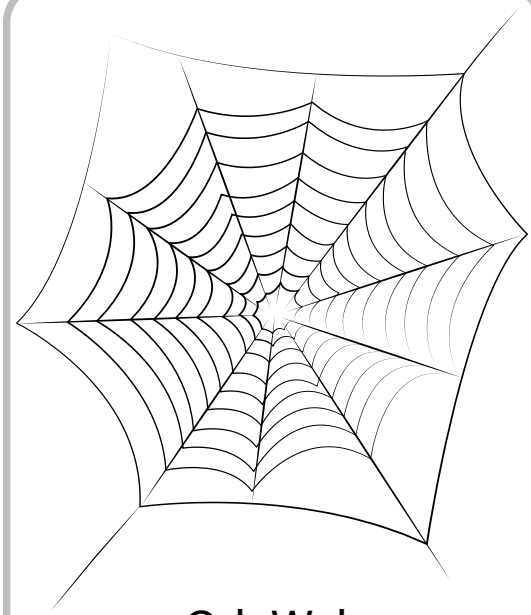
Cob Web



Sheet Web



Funnel Web



Orb Web

Name : _____

Spiderweb Design Challenge

1. Brainstorm possible solutions. Choose a solution and sketch it below.

Type of web: _____

2. Describe how you will build your spiderweb model.

_____

_____

_____

_____

3. Teacher checkpoint ☐

Now build your model!

Name : _____

Inherited Versus Acquired Traits

Sorting Cards

A wolf cub learning to hunt in a pack with other wolves	A trout swimming in a stream
A parrot saying "Hello!"	A girl speaking English and Spanish
A dalmatian puppy being born with spots	A beagle eating so many dog treats that it gets obese
A sunflower plant in a window growing toward the sun	A garden spider hatching from an egg and spinning a web
A bean plant in a dark closet turning yellow	A robin laying an egg in a nest
A jumping spider losing a leg to a centipede	A goldfish swimming to the top of a bowl when it sees your hand holding food
A tiger cub being born with stripes	A boy having brown eyes

Name : _____

Animals in Space Research Proposal Rubric

Component	Description
Title and Introduction *6 Points*	• Choose an animal that you think could survive for a long period of time in orbit around Earth on the International Space Station (ISS). • Research the traits of the animal. • Describe a normal behavior of this animal on Earth. • Identify whether this behavior is **inherited** (instinctive)or **acquired** (learned) and how it is inherited or acquired. • Use supporting details when describing the animal's normal Earth behavior. • Give your proposal a catchy and descriptive title.
Problem Statement *2 Points*	Describe what you want to find out about the animal through a microgravity experiment in orbit ("This experiment seeks to determine if … ").
Prediction *2 Points*	Write a prediction about what you think will happen. The prediction should be based on your observations and research of your animal subject ("If a _____ is sent into orbit, it will/will not be able to _____.").
Methods *6 Points*	• Describe the animal's temporary habitat on the ISS. • Draw a labeled diagram of the animal's habitat. • Describe how your prediction will be tested on the ISS. Explain how scientists will perform the experiment in microgravity. • Describe how you will collect the data (video, photos, tallying movements or behaviors, etc.). • Include a drawing of the animal or experiment in action. • Describe what you will test or observe once the animal returns to Earth's gravity.
Video *4 Points*	Record your presentation. Use a clear speaking voice and look directly at the camera. Props, pictures, and diagrams are helpful! Keep your presentation to 2 min. or less.
Total Score _____/20	Reviewer comments:

Name : _____

Animals in Space Research Proposal

Title: _____

Title: **Introduction:**
Problem Statement:
Prediction:
Methods:

Name : _____

STEM at Home

Dear _____,

At school, we have been learning about **spiders, spiderwebs,** and **inherited traits versus acquired traits**.

I learned that: _____

_____

_____

My favorite part of the lesson was:

_____

_____

_____

At home, we can watch a video from Wild Kratts called "Make a Web," which shows how some spiders make orb webs and how spiders use different kinds of silk for different jobs.

Search for "Wild Kratts Make a Web"on ***www.pbslearningmedia.org*** to find the video at ***www.pbslearningmedia.org/resource/371aa09e-46d0-4665-8a80-5ca94f6cf423/make-a-web-wild-kratts.***

After we watch the video, we can write the steps a spider takes to build an orb web.

1. First, _____.
2. Then, _____.
3. Next, _____.
4. Finally, _____.